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SECTION 32 PROGRAM
STREAMBANK EROSION CONTROL
EVALUATION AND DEMONSTRATION
WORK UNIT 4-RESEARCH ON SOIL STABILITY AND
IDENTIFICATION OF CAUSES OF STREAMBANK EROSION

INVESTIGATION OF A GRID FOR BANK PROTECTION

by

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SECTION 32 PROGRAM

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Introduction

1. Previous tests of five spray-on materials were examined as protection for upper banks* of streams in Investigation Report 1, "Evaluation of Spray-on Stabilizers for Bank Protection," by Jessie C. Oldham, published in February 1979. Three of these materials were effective in helping to establish vegetation, while two of the three were also effective in controlling soil erosion during the test period. Investigation Report 2, "Evaluation of Rigid and Flexible Materials for Bank Protection," by Clarence R. Styron III, published in May 1979, tested two rigid and seven flexible materials to provide protection for lower banks.** Two flexible materials were judged to have definite potential for lower bank protection, provided suitable anchoring devices/methods could be employed. Field tests are currently underway to determine suitable anchoring devices and/or methods and to explore possible construction alternatives.

2. Tests were conducted at the U. S. Army Engineer Waterways Experiment Station (WES) on aluminum grids to determine the suitability of these materials as a potential bank protection system. Specifically, this test would examine a grid/vegetation system in combination as a possible means for controlling bank erosion. The information gathered will be utilized in the Section 32 program entitled "Streambank Erosion Control Evaluation and Demonstration, Work Unit 4 - Research on Soil Stability and Identification of Causes of Streambank Erosion." The system was evaluated for effectiveness and durability in controlling erosion, ease of placement, and cost. It was envisioned that this system might be employed where something more durable than vegetation, but less durable than riprap, is believed necessary.

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* Upper bank is arbitrarily defined as an area that is not flooded frequently enough to warrant riprap, articulated concrete, or other heavy duty protection schemes, but it does nonetheless require protection from rainfall, overland flow/runoff, etc., which is usually accomplished with some suitable tenacious prolific vegetation.

** Lower bank is arbitrarily defined as the section of streambank that is frequently flooded (i.e., one or more times per year) and that may or may not be subject to wave action by wind or other forces.

Test Material

3. An aluminum grid system made in a honeycomb design was used in the test. Each section was fabricated from 0.014-in.- (0.36-mm-) thick 300J-H14 aluminum alloy sheets, formed by bonding into a structure with 6-in.- (15.24-cm-) wide hexagonal cells that are 2 in. (5.08 cm) deep (Photo 1). The size of a section prior to expansion was 1-5/16 in. by 10 ft 1-1/2 in. (3.33 cm by 3.09 m) (Photo 2) and after expansion was 20 by 8 ft (6.10 by 2.44 m) (Photo 3). Each section had a total weight of 27-1/2 lb (12.47 kg) or 0.17 lb per sq ft (0.83 kg/m^2). Two of these aluminum grid sections were used. This test material costs about $0.70 per sq ft.

Test Layout

4. The test area (Figure 1) was located on an open, unprotected slope at the WES. The slope (1V on 1H) was cleared and grubbed. A test section, 50 by 50 ft (15.24 by 15.24 m), was staked out, and sufficient rye grass seed was purchased so that the entire section could be treated at the rate of 200 lb per acre (224 kg/ha). Similarily, 13-13-13 fertilizer was purchased, and the test section was treated at the rate of 400 lb per acre (448 kg/ha).

Placement of Materials

5. On 24 October 1978, the soil was pulverized with the use of a pulver-mixer (Photo 4). The aluminum grids were placed in the center of the 50- by 50-ft (15.24- by 15.24-m) test section and covered with a piece of 3/4-in. (19.05-mm) plywood (Photo 5). The front wheels of a half-ton truck were driven on the plywood to press the grids into the soil (Photo 6). The aluminum grid sections were covered with soil and screeded to assure that each cell was completely filled with soil. The entire sloped test area was watered and compacted using a rubber wheel roller (Photo 7). The entire test section, both grid and adjacent, unprotected area, was fertilized with 13-13-13 and seeded with rye grass. The estimated in-place costs of a combination aluminum grid system with vegetation are $1.70 per sq ft. These costs may be compared with recently estimated values listed on Table 1.

Observations

6. The rye grass, planted on 25 October, began to germinate on 27 November. In the area that had only rye grass for protection from water runoff, rills began to form on 30 November. At this point,

because of the concentrated overland flow of water, a rill 3 to 5 in. (7.62 to 12.70 cm) had formed (Photo 8). The grid section that had a good grass growth started experienced no erosion (Photo 9). The area adjacent to the test section had severe erosion in the unprotected, unseeded area (Photo 10). Observations continued for six months, 1 October - 31 March. One rill protected by rye grass (only) is shown to progress from 3 to 5 in. (7.62 to 12.70 cm) on 5 December (Photo 8) to 8 to 12 in. (20.32 to 30.48 cm) on 12 March (Photo 11). After six months, the area within the grid showed very little or no erosion (Photo 12). Figure 2 presents the amount of monthly precipitation as a bar graph, and Figure 3 shows daily high and low temperatures.

Results

7. The test area with the aluminum grid and rye grass growing in the areas surrounded by the hexagonal cells experienced very little or no erosion. The test area with rye grass (only) growing experienced some erosion, while the area adjacent to the test area experienced severe erosion.

Conclusions

8. Based on the results of the investigation, it was concluded that:

a. Aluminum grids with induced vegetation provide considerably more protection against erosion than vegetation used alone.

b. Vegetation inhibits erosion considerably although in some cases grass growth alone may not be enough to stop all erosion.

c. Denuded lean clay sloped as little as 1V on 4H will experience severe erosion if left unprotected.

Recommendations

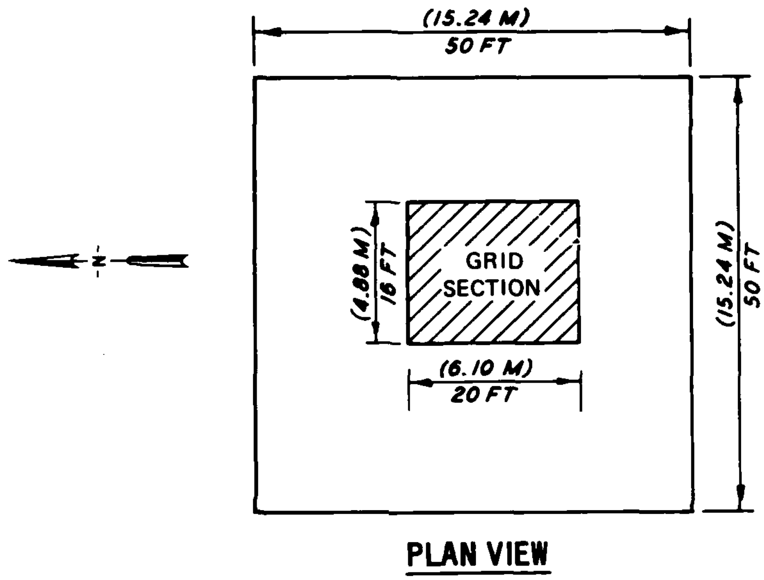
9. This grid/vegetation system is recommended for transition areas where the more expensive erosion control measures are not justified, but something more substantial than simple vegetation growth is necessary.

Table 1

In-Place Cost Summary
for the Streambank Protection Methods

Streambank Protection Method	Cost/Unit, $	Unit
	1976 Costs*	
Stone riprap	3.50-30.00	yd^3
Concrete pavement	90-125	100 ft^2
Articulated concrete mattresses	84	100 ft^2
Transverse dikes:		
Pile board	40-55	lin ft
Untreated clumps	1400-2300	clump (three piles 60 ft)
Stone	40-65	lin ft
Fences	25-50**	lin ft
Asphalt mix (upper bank)	60-80	yd^3
Kellner jack field	16-47†	lin ft
Vegetation (grass)	1.15-1.49 (500-650)	100 ft^2 (acre)
Gabions	40-47	yd^3
Erosion-control matting	5.56-7.22 (0.50-0.65)	100 ft^2 (yd^2)
Bulkheads	14-105	lin ft
	1978 Costs	
T15 membrane	0.41	ft^2
T16 membrane	0.44	ft^2
M8A1 mat	5.00††	ft^2
Rolled aluminum mat	10.00††	ft^2

* Cost figures supplied by Corps of Engineers Divisions and Districts.
** Range applies to new materials.
† Range applies to used and new materials.
†† Estimated costs.



NOTE: The 16- by 20-ft grid section indicates areas where the 6-in.- (15.24-cm-) wide hexagonal cell aluminum grid is located. The entire 50- by 50-ft (15.24- by 15.24-m) area was fertilized and seeded with rye grass seed. All adjacent areas were left denuded and unprotected.

Figure 1. Layout of test plot

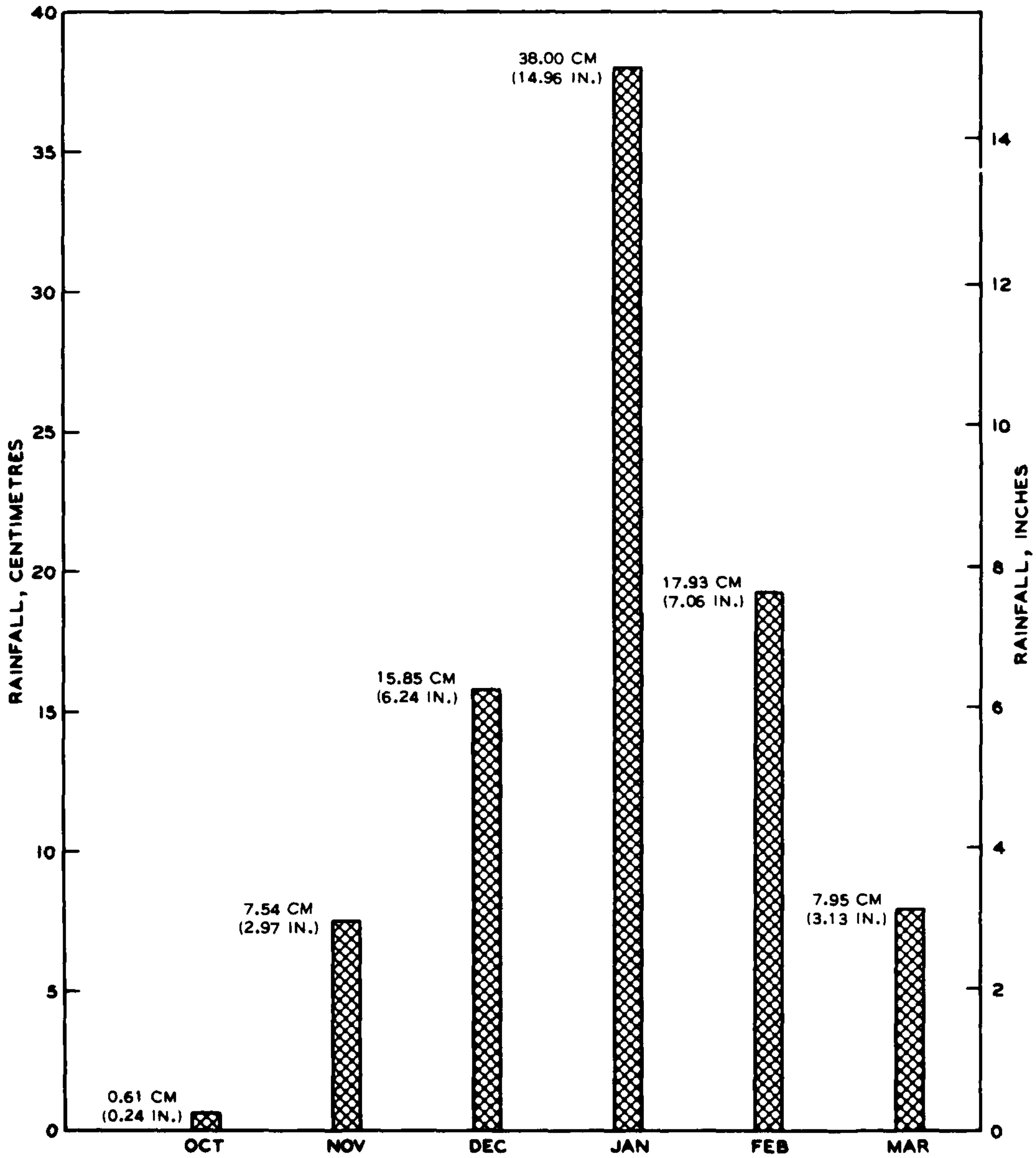
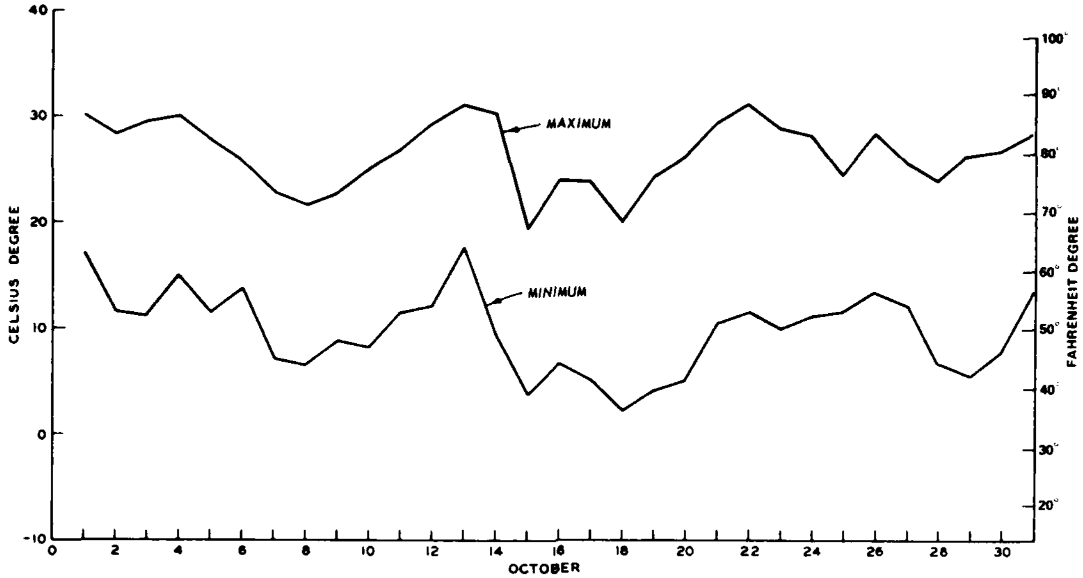


Figure 2. Accumulated monthly rainfall



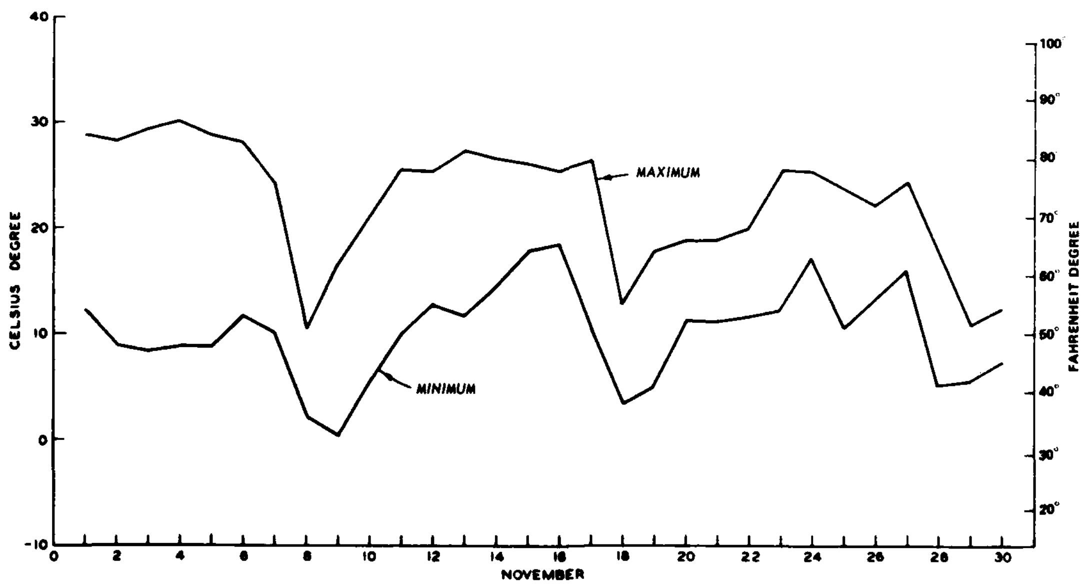
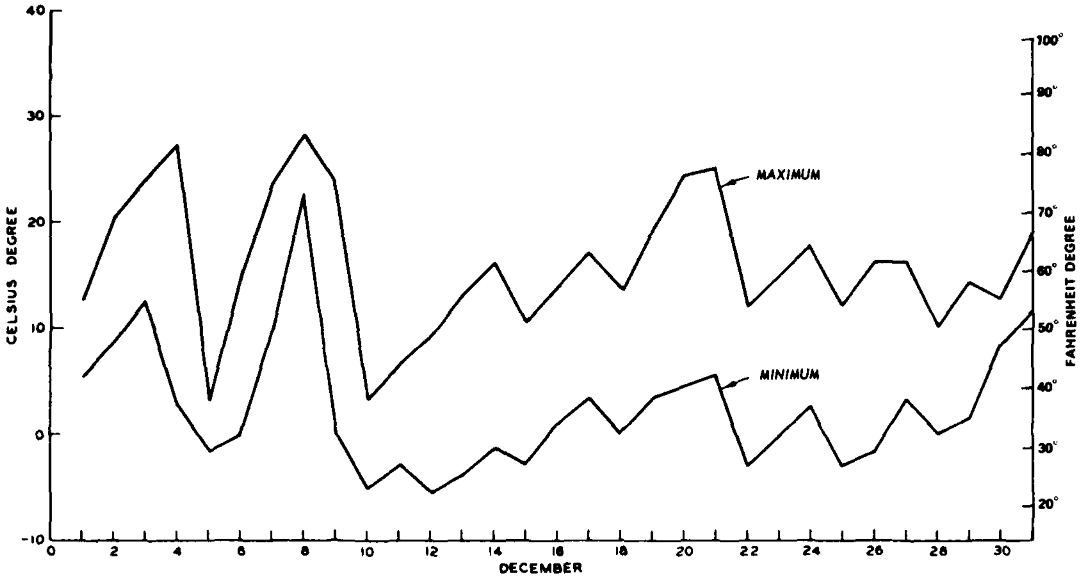


Figure 3. Daily air temperature extremes (Sheet 1 of 3)



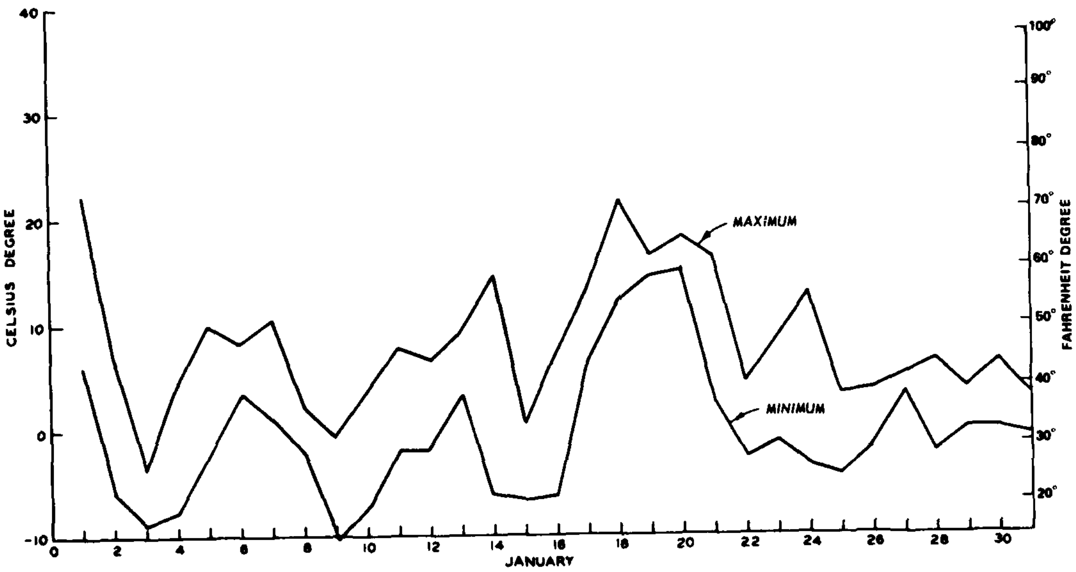
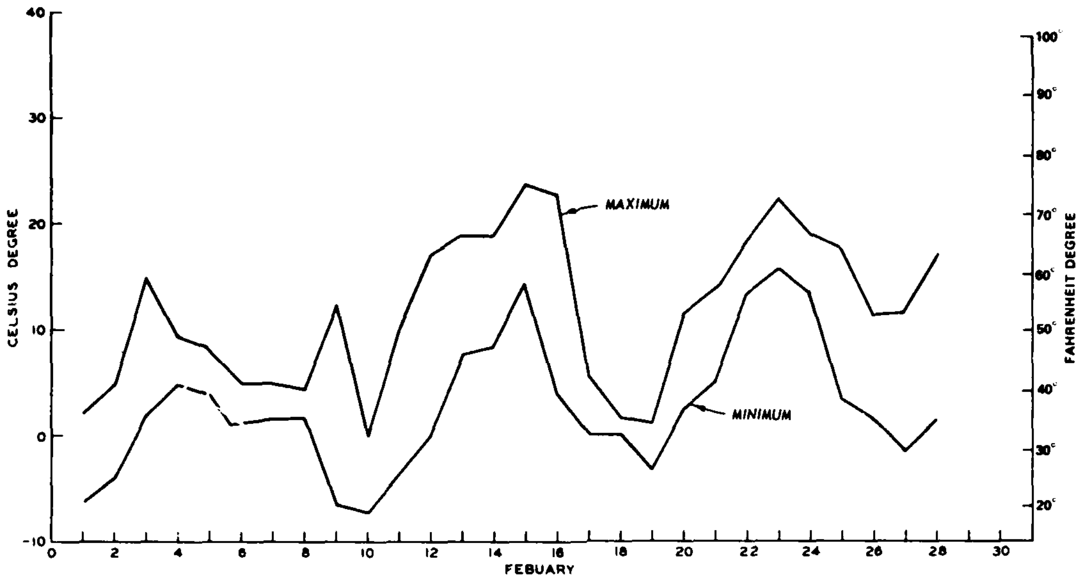


Figure 3. (Sheet 2 of 3)



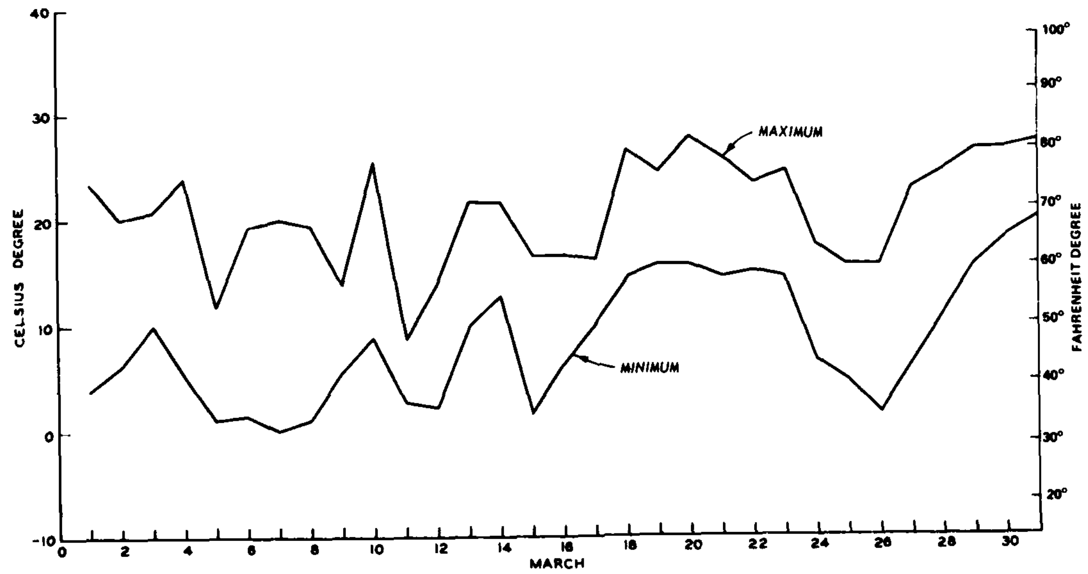


Figure 3. (Sheet 3 of 3)

Photo 1. Aluminum grid with 6-in.- (15.24-cm-) wide hexagonal cells that are 2 in. (5.08 cm) deep

Photo 2. Aluminum grid sections as received from manufacturer (prior to expanding and placing grids on test site)

Photo 3. Grid being placed by hand

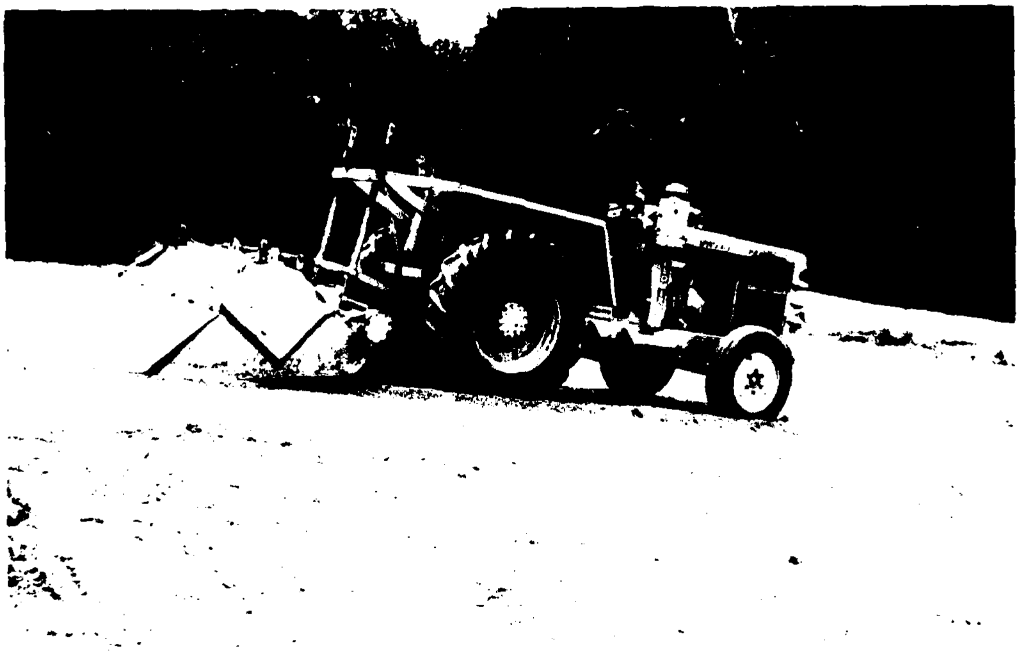


Photo 4. Pettibone speed mixer (pulver-mixer)

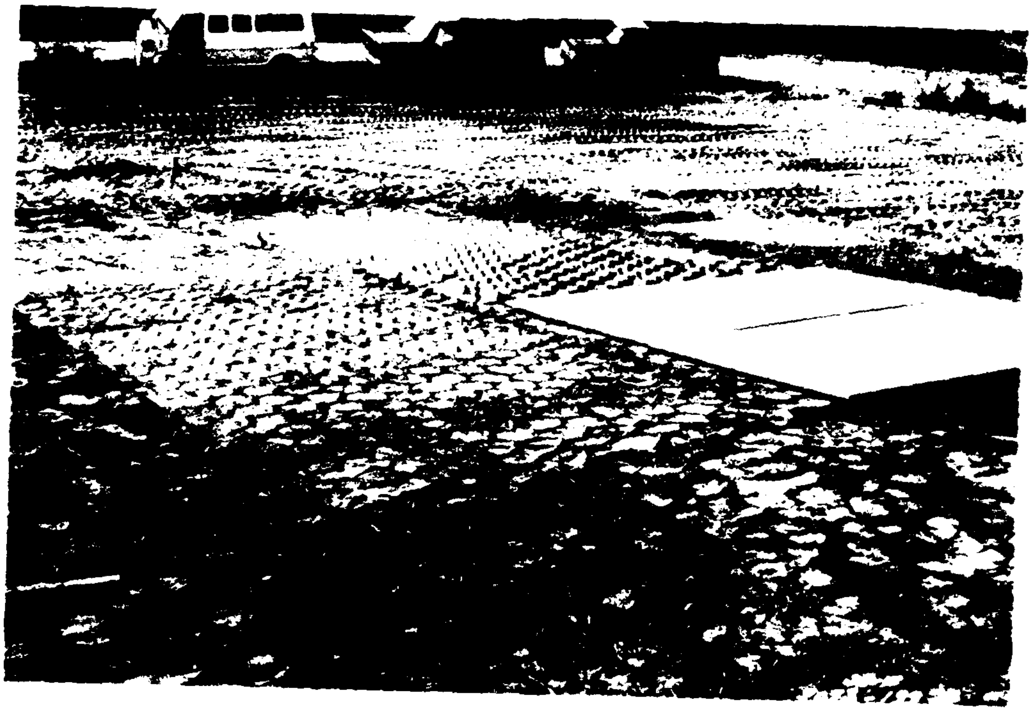


Photo 5. Three-quarter-inch (19.05-millimetre) plywood on top of grid

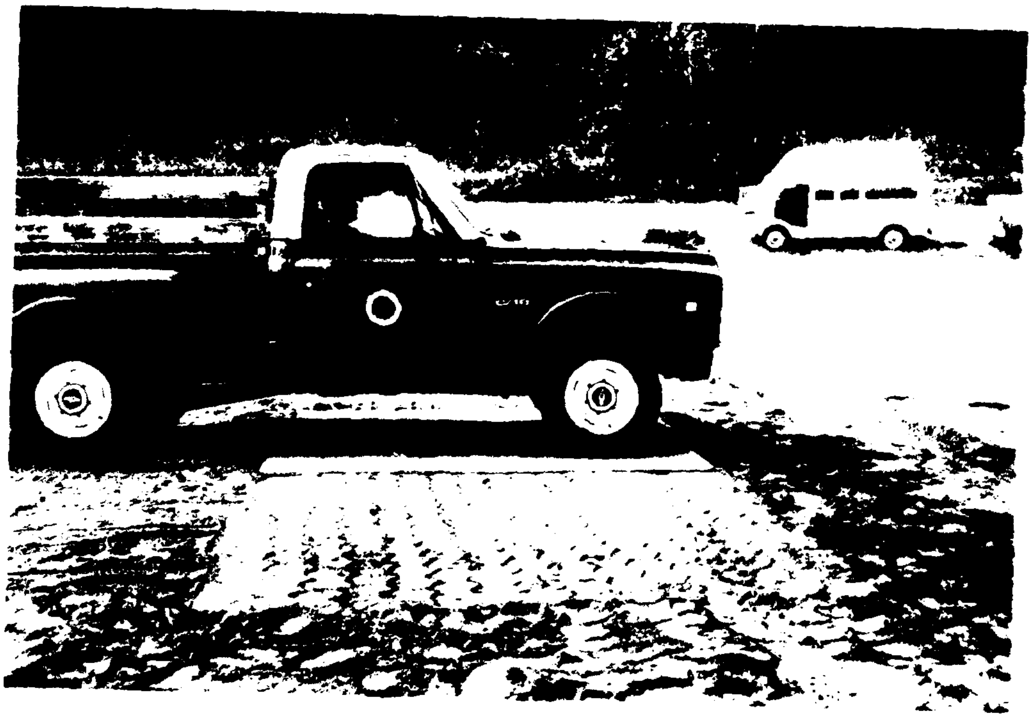


Photo 6. Half-ton truck driven on plywood to bury grid

Photo 7. Rubber wheel roller used for compaction purposes

Photo 8. Rill development (3 to 5 in. (7.62 to 12.7 cm) deep) in grassed section without grid, 5 December 1978 (compare with Photo 12)

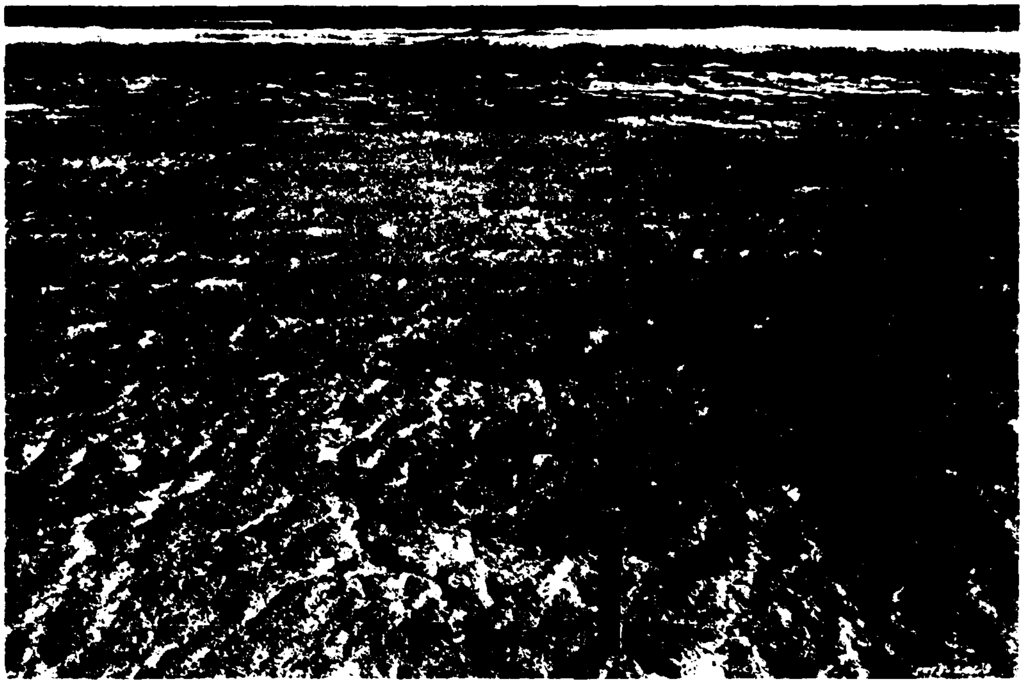


Photo 9. Grid section with good grass growth

Photo 10. Severe erosion in unprotected, unseeded area adjacent to test area (covered areas below and to the right of the test area will be discussed in a subsequent report(s))

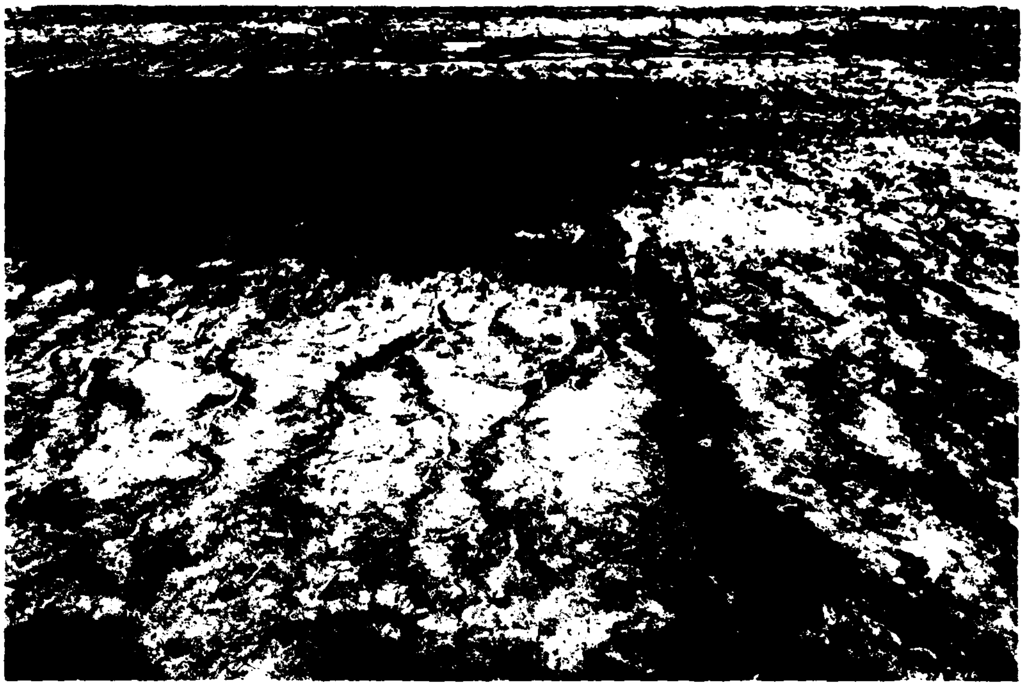


Photo 11. Rill development (8 to 12 in. (20.32 to 30.48 cm) deep) in grassed section without grid, 12 March 1979 (compare with Photo 8)

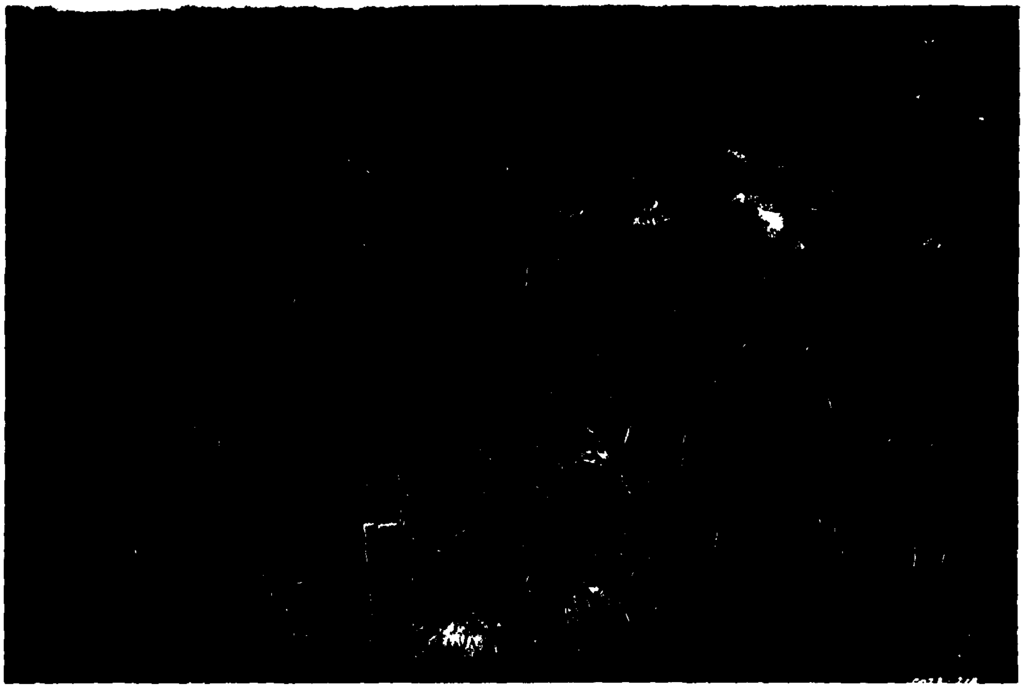


Photo 12. After six months, very little or no erosion seen in the grid section